DOCUMENT RESUME

ED 317 086 FL 018 442

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TITLE	Teaching Mathematics to Limited English Proficient Students. ERIC Digests.
INSTITUTION	ERIC Clearinghouse on Languages and Linguistics, Washington, D.C.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
REPORT NO	EDO-FL-89-03
PUB DATE	Nov 89
CONTRACT	RI88062010
NOTE	4p.
PUB TYPE	Information Analyses (070) -- Information Analyses - ERIC Information Analysis Products (071)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Cultural Awareness; Cultural Differences; *Curriculum Development; *Limited English Speaking; *Material Development; *Mathematics Instruction; Student Evaluation; *Teacher Education
IDENTIFIERS	Content Area Teaching; *ERIC Digests

ABSTRACT

A mathematical problem is used to illustrate the difficulties non-native or limited-English-speaking students may encounter while attempting to solve mathematical problems in English. Simply knowing the language of instruction and the required math skills may not be sufficient for solving math problems. Cultural issues are present as well. It is suggested that instruction should be sensitive to both the cultural and linguistic needs of language minority students. Instruction that emphasizes language activities should be incorporated into content area lessons and curricula. This requires development in teacher training, curricula and materials, assessment, and cooperation between content and language educators. (Author/VWL)

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Teaching Mathematics to Limited English Proficient Students

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ERIC Digest

Teaching Mathematics to Limited English Proficient Students

Prepared by Deborah J. Short and George Spanos

November 1989

At an in-service workshop on content-based instruction, the facilitator presents an exercise designed to increase awareness of the difficulties encountered in learning mathematics in a second language. The participants are instructed to solve the following word problem in a language with which they have little or no familiarity (French), and to think about some questions that focus on factors involved in problem solving.

Jean et André sont frères. Jean est l'aîné. Les deux vont au lycée qui se trouve à moins de cinq kilomètres de leur maison à Paris. Bien qu'il y ait une différence d'âge de trois ans entre les deux frères, leurs niveaux scolaires ne sont séparés que par deux années. Jean est en quatrième. En quelle classe est André?

1) What are the language difficulties in this problem?
2) What are some math difficulties in this problem?
3) What are some extra-linguistic features that could cause difficulty in solving this problem?

The participants study the problem and try to answer the questions. They begin to realize the difficulties word problems may pose for nonnative-speaking students. The facilitator lists some possible language difficulties:

difficult lexical items, such as *aîné, niveaux, ait;*
comparative terms or structures, such as *aîné,* and *moins de;*
grammar structures with relative and subordinate clauses, such as *qui se trouve à, bien qu'il y ait.*

Before announcing the solution, the facilitator distributes an English version of the problem that simulates a student's word-for-word attempt at translating it.

Jean and Andre are brothers. Jean is older. The two go to a school which is found less than five kilometers from their home in Paris. Although there is a difference in age of three years between the two brothers, their grade levels are only two years apart. Jean is in the fourth. What class is Andre in ?

The group discovers some potential math pitfalls in the wording of the problem. There is extraneous information--unnecessary numbers (*five kilometers, three years*)--and a mixture of cardinal (*two, three*) and ordinal (*fourth*) numbers.

The facilitator then gives the answer: Andre is in the 6th grade at school. You are surprised. You had concluded that Andre was in second grade. After all, 4 - 2 = 2. In response to challenges by participants, the facilitator directs attention to question number 3 on the worksheet.

The facilitator explains that simply knowing the language of instruction and the required math skills may not be sufficient for solving problems. Cultural issues may be present as well. In this problem, one needs to know that the French educational system counts the grade levels in secondary school from 6th (youngest) to 1st (oldest). A teacher must be careful not to assume that all students have the same background knowledge.

The Need for Language-Sensitive Content Instruction

The preceding example suggests the desirability of instruction that is sensitive to the linguistic and cultural needs of language minority students. From the language educator's point of view, it is obvious that a lack of proficiency in the language of instruction has harmful effects on a student's ability to deal with content-area texts, word problems, and lectures. Many language educators (e.g., Spanos, Rhodes, Dale and Crandall, 1988) and a growing number of mathematics and science educators (e.g., Cuevas, 1984, and Mestre, 1981) are providing arguments suggesting that the nature of math and science language imposes a heavy burden on *all* students regardless of the language of instruction. Furthermore, national organizations, such as the National Council of Teachers of Mathematics (NCTM), the Mathematical Sciences Education Board (MSEB), and the American Association for the Advancement of Science (AAAS) are calling for an approach to education that emphasizes communication for all students, at all school levels.

The recently-published NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989) lists *learning to communicate mathematically* (p. 8) as one of its five major goals. The NCTM authors maintain that all students can benefit from listening, reading, writing, speaking, and demonstration activities (pp. 26-28, 78-80, 140-142). For nonnative speakers of English, the NCTM states: Students whose primary language is not the language of instruction have unique needs. Specially designed activities and teaching strategies (developed with the assistance of language specialists) should be incorporated into the high school mathematics program in order for all students to have the opportunity to develop their mathematics potential regardless of a lack of proficiency in the language of instruction (p.142).

The MSEB (1989) supports this call for more communication, recommending that teachers engage students in the construction of mathematical understanding through the use of group work, open discussions, presentations, and verbalization of mathematical ideas (p. 58). The MSEB advocates the use of non-traditional teaching models, such as paired classes, that have one teacher for language arts and one for mathematics and science (p. 65).

Such statements challenge language and content-area educators to begin working together to educate students for whom basic English skills or academic language skills are an obstacle to success.

Focusing on the Language of Mathematics

Some research on content-based instruction has focused on the language of mathematics. In 1984, researchers from the Center for Applied Linguistics (CAL) (Crandall, Dale, Rhodes, and Spanos, 1984) initiated a project funded by the Fund for the

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Improvement of Postsecondary Education (FIPSE). This study involved collaborative research with mathematics educators at several two-year colleges with high language minority enrollments, and led to the development of a set of materials that could be used as a language-focused supplement to beginning algebra classes. The research phase of the project involved group problem-solving activities with language minority and majority students. The researchers produced evidence that the performance of both types of students was severely impeded by a lack of proficiency in the language of mathematics. Further, there were few language-based materials or activities in mathematics classrooms, and fewer opportunities for language arts teachers to become involved in educating these students. In sum, there was little articulation between language arts programs and mathematics programs, despite the obvious language deficiencies faced by large numbers of students enrolled in mathematics.

Meeting the Communication Need

Language minority students are often quick to develop the social language skills that enable them to communicate with their peers outside of the classroom. Within an academic context, however, this basic proficiency is inadequate because language minority students are inexperienced with or lack an understanding of the terminology and writing styles particular to a content area. These students may not be prepared to perform the higher order language and cognitive tasks required in rigorous academic content courses. This latter point also applies to native speakers of English who are often not skilled in analysis, argumentation, and evaluation.

Instruction that emphasizes language activities should be incorporated into content area lessons and curricula. This requires development in teacher training, curricula and materials, assessment, and cooperation between content and language educators.

Teacher Training. Training workshops and seminars can provide content teachers with an opportunity to consider language objectives and increased communication in their classes. An important aspect of these training seminars is the joint participation of content and language educators, providing opportunities for cooperative activities that draw on the expertise of both disciplines. Training seminars present teachers with the theoretical background for integrating language and content and provide opportunities for application through analyses of curricula, suggested instructional strategies and techniques, and assessment tools. Techniques include discovery learning, hands-on and problem-solving activities, cooperative learning and group work, and peer tutoring.

Teacher training can also be provided through the use of video. Several videos, currently under production (see Resources), demonstrate the content/language approach and materials, and have accompanying manuals, for use by teachers for self-instruction when direct training is unavailable.

Curricula and Materials. Once teachers have been trained to increase communication in class, they need appropriate materials for developing their lessons and activities. Teachers can attend workshops on material adaptation where they can learn to modify existing materials for their particular needs. In such workshops, strategy sheets (see Cuevas, Dale, Richardson, Tokar, & Willets, 1986) are used as developmental models. These srategy sheets focus on content and language objectives in lesson plans designed with communicative activities. Teachers might consider using prepared supplemental materials (*e.g., English Skills for Algebra*, Crandall, Dale, Rhodes, and Spanos, 1989) that help students become more proficient in the academic language through interactive listening, speaking, reading, and writing activities.

Assessment. Although assessment tools for determining concept mastery of mathematics, science, and social studies are numerous, instruments for measuring content area language proficiency are scarce. Assessment tools, such as the *Pre-Algebra Lexicon* (see References), are currently being developed and field tested. The diagnostic techniques in the Pre-Algebra Lexicon are organized according to four math categories (concepts, operations, word problems, and problem solving) and the four language skills (listening, speaking, reading, and writing). The techniques allow teachers to assess growth in language skills within the context of daily mathematics instruction.

Cooperation Between Language Educators and Content Educators. Content teachers need to implement strategies for increasing teacher-student and student-student interaction in the classroom and to emphasize communication of the concepts. Language teachers need to address content language in their classes. Collaboration between content and language teachers can be beneficial and essential to both, as language teachers can provide insights into linguistic and cultural problems and offer communicative activities for overcoming these problems, and content teachers can suggest topics for the language courses that reinforce the content the students face. These collaborative efforts can help students develop greater language proficiency and concept mastery.

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This report (EDO-FL-89-03) was prepared with funding from the Office of Educational Research and Improvement, U.S. Department of Education, under contract no. RI88062010. The opinions expressed in this report do not necessarily reflect the positions or policies of OERI or ED.